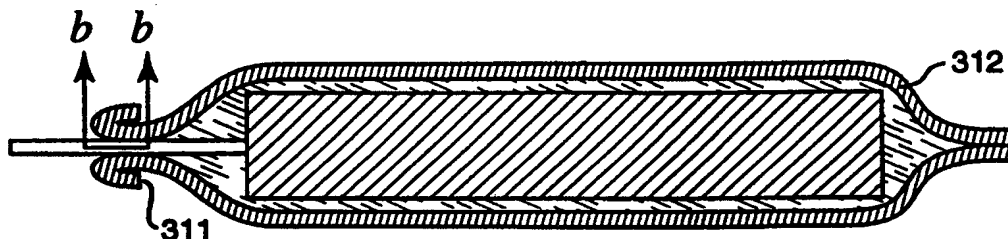




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(21) International Application Number: PCT/US99/01054 (22) International Filing Date: 19 January 1999 (19.01.99) (30) Priority Data: 09/008,889 20 January 1998 (20.01.98) US (71) Applicant: VALENCE TECHNOLOGY, INC. [US/US]; 301 Conestoga Way, Henderson, NV 89015 (US). (72) Inventor: CHEU, S., Scot; 3858 Heppner Lane, San Jose, CA 95136 (US). (74) Agents: DESCHERE, Linda, M. et al.; Young & Basile, P.C., Suite 624, 3001 West Big Beaver Road, Troy, MI 48084-3107 (US).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>

(54) Title: BATTERY TERMINAL INSULATION**(57) Abstract**

The subject invention provides a battery pouch or container which is highly resistant to shorting. This electrical protection is produced by a folding of the packaging laminate such that the cut edge of the laminate is physically removed and electrically protected from the electrode tab which protrudes from the battery pouch. In one embodiment, the cut edge of the film is folded away from the electrode tab. In a preferred embodiment, the laminar packaging material includes a convex flap of material where the electrode traverses the package. The convex flap is folded away from the electrode tab without wrinkling or distorting the pouch shape. In an alternate embodiment, an intervening layer of insulative material is placed between the cut edge and the electrode tab.

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Battery Terminal Insulation

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Technical Field

The present invention relates to the manufacture of packaged battery assemblies, and more specifically to packaging for laminar lithium ion batteries. An improved laminate packaging is disclosed.

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Background of the Invention

Polymer matrix lithium ion cells are the newest of the commercially available battery cells. During the production of these cells, an electrolyte salt solution (electrolyte salt and electrolyte solvent) is imbibed into a polymeric matrix structure to yield a functional, "activated" battery system. Because the battery structure is defined by a polymer matrix, the electrolyte salt solution permeates the entire battery structure. Liquid electrolyte also commonly extends beyond the borders of the battery, filling or partially filling the battery packaging. It is common to use a heat-sealable laminate as the packaging material.

Lithium ion battery packaging may be plastically formed, or may be pouched. Both formed and pouched packaging structures are generally heat-sealed. A pouched structure is shown in **Figure 1**. A laminated polymer matrix

battery structure **110** is enclosed between heat-sealed laminated layers **112a, b** which form a pouch. The pouch is sealed around electrode tabs **114** while permitting the tabs **114** to extend from the otherwise-enclosed pouch. This permits electrical contact to, and use of, the battery via the electrode tabs **114**. As
5 noted previously, electrolyte **116** may also be found within the pouch.

Battery packaging materials will vary with the battery manufacturer and the specific application. However, a typical packaging laminate, **212a, b**, of the prior art is shown in **Figure 2**. This represents a laminate layer **212a, b** on each side of a metal foil layer **220**, such as that taken at *line a-a* of **Figure 1**. This
10 shows two layers of laminate, **112a** and **112b**, which have been heat-sealed to enclose the battery pouch while permitting the electrode tab **214** to extend past the borders of the pouch.

The laminate material **212a, b** includes a foil layer **220**. The foil layer is located generally centrally within the laminate. At one surface of the foil layer is the inner laminar region **213**. At the opposite surface of the foil layer is an outer
15 laminar strata **222**. The outer laminar strata **222** is provided as a package electrical insulator, for physical package protection, and for package marking or labeling.

The foil layer **220** acts as a barrier to oxygen and moisture incursion into
20 the battery package. The foil also provides rigidity to the package, and provides structural support if the package is pre-formed into a specific shape. However, metal foil **220** can be reactive with lithium ions (Li^+) of the electrolyte. An inner

strata **213**, designed to be nonreactive with the electrolyte, is provided between the foil layer and the package. The inner laminar region **213** should be inert to the enclosed electrolyte salt solution during battery storage and during battery use.

An inner laminar region **213** is positioned between the metal foil and the inside of the package. The inner laminar region has several functions. It provides a physical barrier between the metal foil and the electrolyte salt solution. Upon sealing, it provides a nonconductive barrier between the metal foil and the electrode tabs, which preliminarily prevents package shorting. It aids in plastic formation of the package, and it provides a self-sealing bond. Two layers of the package laminate can be placed with the inner laminar layers abutting each other. When an appropriate heat and pressure are applied, a heat-seal bond is produced.

The inner laminar region **213** generally includes a layer of polyamide **224** such as a nylon, and a heat-fusible sealing layer **226**. Other layers which may be present but which are not pictured include tie layers (which act to adhere layers in position), or layers which promote formation or duration of the laminate material or of the pouch.

The polyamide layer **224** is located between the metal foil layer **220** and the heat-sealable layer **226**. The polyamide layer acts as an insulative layer, keeping the body of the battery electrode tab electrically isolated from the body of the metal foil layer. This separation of the electrode tab and the package foil layers avoids

electrical shorts between the body of the battery tab(s) and the body of the laminar package.

Summary of the Invention

Unfortunately, pouch materials are generally produced by cutting the
5 material to size, either before or after the pouch has been formed by heat-sealing or other mechanical or chemical processes. This cutting process leaves an exposed cut edge 211 of the laminar material. The electrode tab 214 is directly adjacent the cut edge 211, including the metal layer 220. It is very easy for extraneous debris to cause a short between the metal layer 220 and the electrode
10 tab 214.

A short can also occur between the battery and the packaging if the cut edge 211 of the laminate curls toward the electrode tab 214. Touching of the metal layer of the laminate (which is exposed at the cut edge 211) to the electrode tabs 214 can cause a battery short. The potential for shorting between the cut edge of the
15 battery package and the enclosed battery package was not recognized or addressed by the prior art.

The subject invention provides a battery pouch or container, produced from a laminar sheet, which is highly resistant to shorting. This electrical protection is produced by a folding of the packaging laminate such that the cut edge of the
20 laminate is physically removed and protected from the electrode tab which protrudes from the battery pouch. In one embodiment, the cut edge of the film is

folded away from the electrode tabs. This folding provides insulative layers of the laminate, rather than a cut edge, adjacent each the electrode tab. In a preferred embodiment, the laminar packaging material includes a convex flap of material where the electrode traverses the package. The convex flap is folded away from
5 the electrode tab without wrinkling or distorting the pouch shape.

In an alternate embodiment, an intervening layer of insulative material is placed between the cut edge and the electrode tab. Conveniently, the layer of insulative material is an electrically nonconductive tape which occludes the cut edge of the pouch laminate at the electrode tab, or which covers the electrode tab
10 adjacent the cut edge.

Brief Description of the Drawings

Figure 1 shows a cross-sectional view of a battery pouch package of the prior art.

Figure 2 shows a cross-sectional view of a battery pouch taken through *line a-a* of **Figure 1**.
15

Figure 3 shows a cross-sectional view of a battery pouch of the subject invention having edges folded at the electrode tab.

Figure 4 shows a cross-sectional view of a battery pouch of the subject invention, taken through *line b-b* of **Figure 3**.

Figure 5a shows a top view of a battery pouch having a convex overhang at each electrode tab. **Figure 5b** shows a top view of a battery pouch of **Figure 5a** in which the convex overhangs have been folded back to remove the cut edges from the electrode tabs.

5 **Figure 6** shows an alternate cross-sectional view of a battery pouch of the subject invention which employs an electrically non-conductive material to occlude the cut edge of the pouch laminate.

The figures herein are for illustrative purposes only. They are graphic representations, and are not drawn to scale.

10

Detailed Description of the Invention

A typical laminar lithium ion cell battery includes an anode of a lithium insertion compound; a separator structure or electrolyte film layer; a cathode including electrochemical active material; and an electrolyte prepared from an electrolyte salt and a solvent, such as an inorganic lithium salt dissolved in an organic solvent. Each of the solid battery components is defined by a polymeric matrix structure. Such batteries are well-known in the art and examples of such are set forth in U.S. Patent numbers 4,997,732; 4,207,389; and 5,456,000.

The laminar lithium ion cells include at least one, and generally at least two, electrode tabs extending from the battery, through the packaging, and extending outside the packaging. The electrode tabs provide a route for charging and discharging the packaged battery. Electrode tabs are well known to the art.

20

A typical laminate sheet has two faces and four edges. Each of the faces is formed by, and parallel to the axis of, the laminar strata. The "outer face" is generally protective, insulative, and may have commercial or manufacturing data printed on it. The outer face is that which is exposed when the laminate sheet has been formed into a battery package or pouch. The outer face is defined by the outermost surface of the outer laminar strata. The "inner face" is generally insulative, and is processable using heat, mechanical, or other means to seal the package or pouch. The inner face provides the inner surface(s) of the battery package, nearest the enclosed battery. The inner face is defined by the innermost surface of the inner insulative region.

Located between the strata forming the inner face and the outer face is a metal foil. The foil layer acts as a barrier to oxygen and moisture incursion into the battery package. The foil also provides rigidity to the package, and provides structural support if the package is pre-formed into a specific shape. The foil layer is generally flexible, and/or moldable by press-molding. Appropriate foils include "soft" metals such as small-grained aluminum foils, as known to the packaging art. While this metal layer is resistant to degradation by lithium in the electrolyte, it is capable of shorting out the battery if it comes in contact with the electrode tabs.

The "edges" (of which there are typically four, but the number can be varied as desired) are generally perpendicular to the two faces. The edges can be formed by cutting of a larger sheet, by manufacture during the manufacture of the

laminar region and the metal foil layer are exposed. A cut edge can conveniently
5 be produced by cutting, but may also be produced as an edge in manufacturing or construction of the laminate a variety of physical means.

The invention herein provides a means and a method for separating the cut edge of the battery package from the electrode tab(s), using both physical and electrical separation.

10 In a first embodiment of the invention herein, shown in **Figure 3**, the laminar packaging material **312** is folded near the periphery. This fold moves the cut edge **311** so that it is no longer adjacent the electrode tab **314**. Rather, the laminate **312** is doubled back upon itself.

Figure 4 shows a cross-section of **Figure 3**, taken through *line b-b*. The
15 electrode tab **414** extends between two laminar sheets **412** (only one of which is shown) that form the battery pouch. The cut edge **411** of the laminar sheet **412** is folded to double back, parallel to the general axis of the pouch material. The folded inner laminar region **413** shapes to protect the foil layer **420** and the cut edge **411** of the laminar sheet **412** from the electrode tab **414**. This fold both places
20 insulative material between the cut edge **411** and the electrode tab **414**, and positions the cut edge **411** away from the electrode tab **414**.

Figure 5a shows a preferred pouch precursor, in which a convex flap **515** or edge is formed in the laminar pouch material **512** adjacent the electrode tab **514**. The cut edge **511** extends along the periphery of the entire pouch.

Figure 5b shows the pouch of **Figure 5a** in which each convex flap **515** has been folded back over the body of the pouch material **512**. The pouch does not have a cut edge **511** proximal to the electrode tabs **514**. This embodiment is preferred because the folding of the convex edges is less likely to stress the pouch seals than can the folding of a straight edge.

An alternate embodiment is shown in **Figure 6**. An insulative material **625** such as an insulative tape or a pre-formed capping structure is placed to occlude the cut edge **511**. The insulative material **625** acts to physically and electrically isolate the metal foil layer **620** from the electrode tabs **614**.

Another embodiment (not shown) uses insulative tape which is placed directly on the electrode tab, interposed between the electrode tab and the cut edge.

While the invention has been described in connection with several exemplary embodiments, it will be understood that many modifications will be apparent to those of ordinary skill in the art in light of the above disclosure. Reference to the following claims should be made to determine the scope of the claimed invention.

Claims

I Claim:

1. A battery package, said package comprising:
 - (a) a battery having at least one electrode tab protruding therefrom;
 - (b) a pouch which encloses said battery, and which partially encloses said electrode tab, said pouch being formed from laminar pouch material including a central metal foil; said laminar pouch material having a cut edge proximal to said electrode tab; and
 - (c) a means for separating said cut edge from said electrode tab.
2. A battery package of Claim 1 wherein the means for separating said cut edge from said electrode tab is an intervening nonconductive material.
3. A battery package of Claim 2 wherein the nonconductive material is a tape which covers the cut edge of the laminar pouch adjacent the electrode tab.
4. A battery package of Claim 2 wherein the nonconductive material is a tape which covers the electrode tab adjacent the cut edge of the laminar pouch.
5. A battery package of Claim 1 wherein said means for separating said laminar pouch edge from said electrode tab comprises a fold in the laminar material such that the edge of the material is oriented to be distal to the electrode tab.

6. A battery package of Claim 5 wherein a convex edge is present in the laminar material adjacent the cut edge, and said convex edge is folded back to remove the cut edge from the electrode tab.
7. A method for preparing a pouch which is useful for battery packaging, said method comprising:
- (a) providing a battery having at least one electrode tab protruding therefrom;
 - (b) forming a pouch to enclose said battery and partially enclosing said electrode tab; said pouch being formed from a laminar pouch material including a central metal foil, said laminar pouch material including at least one cut edge; and
 - (c) providing a means for separating said cut edge from said electrode tab.
8. A method of Claim 7 wherein said providing a means for separating said cut edge from said electrode tab comprises folding a section of the laminar pouch to physically separate the cut edge from the electrode tab.
9. A method of Claim 7 wherein said providing a means for separating said cut edge from said electrode tab comprises providing an electrically insulative material between the cut edge of the laminar pouch and the electrode tab.

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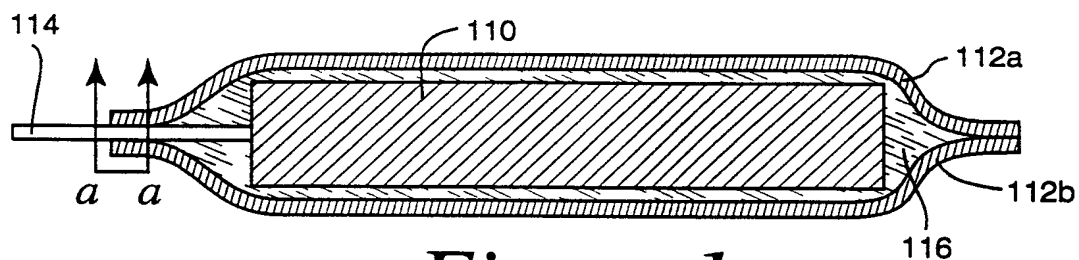


Figure 1
(Prior Art)

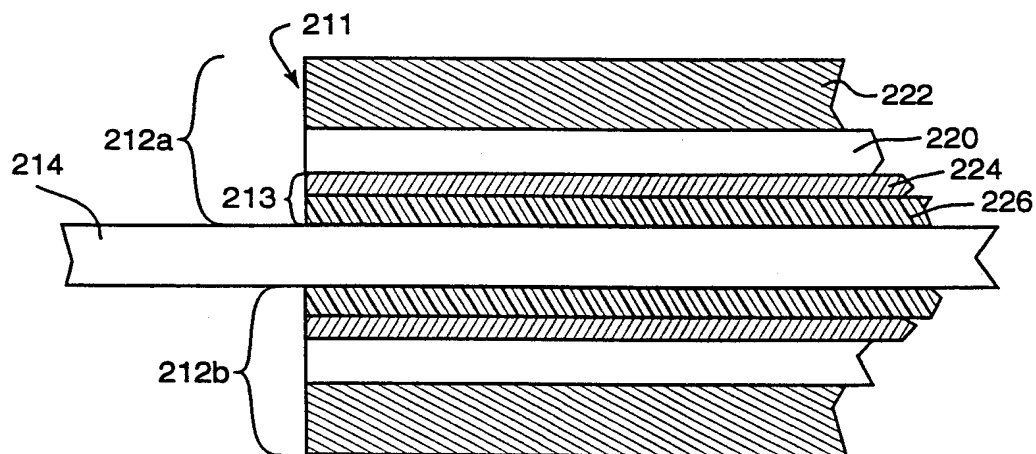
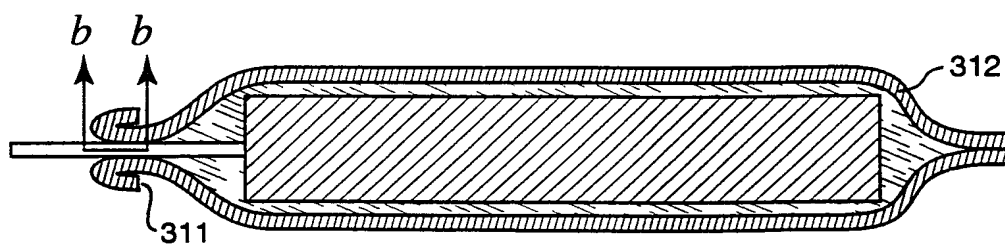
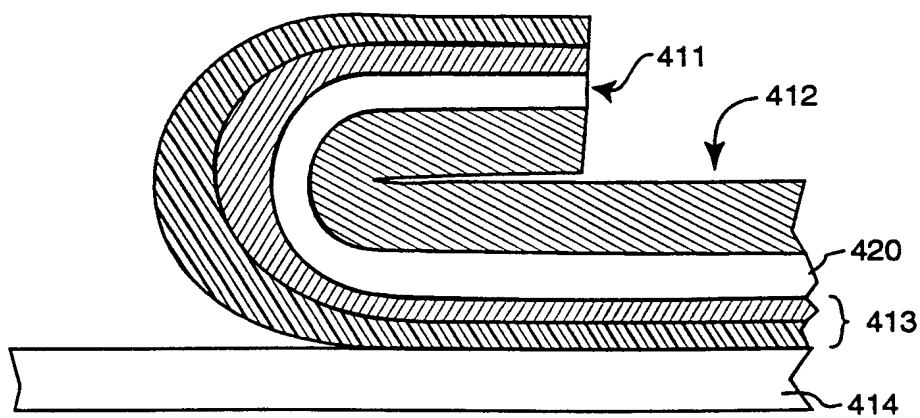
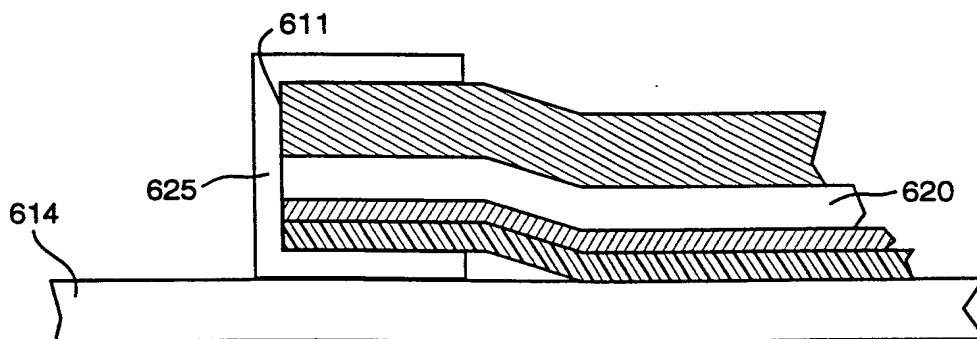
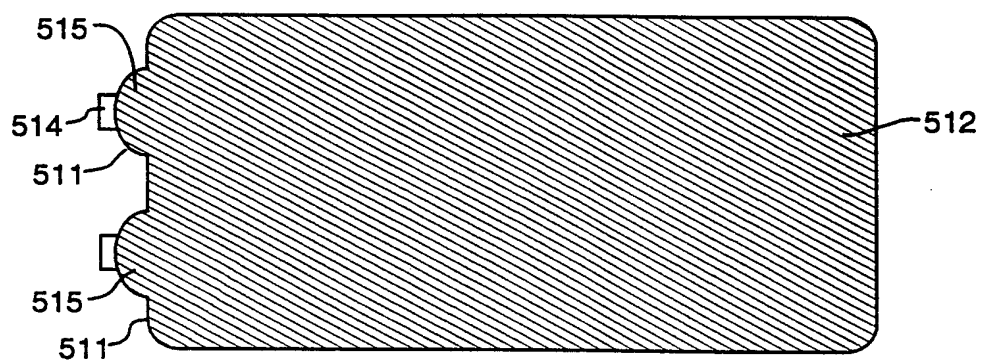
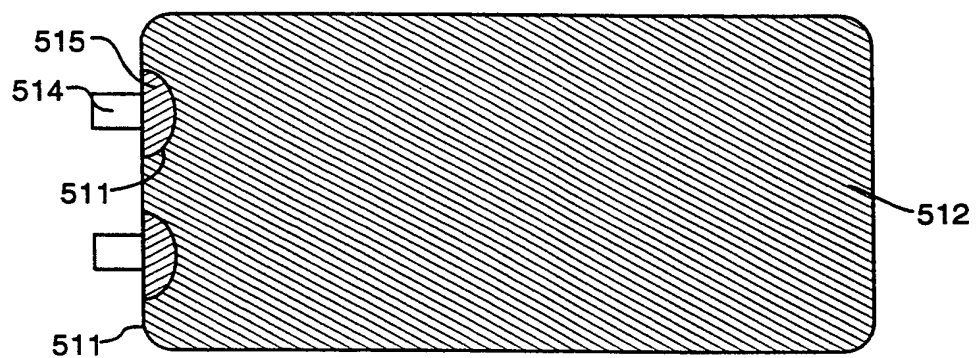


Figure 2
(Prior Art)

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*Figure 3**Figure 4**Figure 6*

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*Figure 5a**Figure 5b*

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/01054

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H01M2/02 H01M2/20 H01M2/08 H01M2/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 40540 A (FUKUDA YUTAKA ;HANAFUSA KOJI (JP); TANAKA KEIICHI (JP); SUMITOMO E) 30 October 1997	1-4, 7, 9
P, X	& EP 0 852 404 A (SUMITOMO ELECTRIC INDUSTRIES LTD) 8 July 1998 see page 3, line 14-24 see page 3, line 56 - page 4, line 9 see figures	1-4, 7, 9
P, X	WO 98 42036 A (SASAYAMA MASA AKI ;ASAHI CHEMICAL IND (JP); MINAKATA TAKASHI (JP);) 24 September 1998 see abstract see figures	1, 7
A	EP 0 397 248 A (EASTMAN KODAK CO) 14 November 1990 see the whole document	1-9

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Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>PATENT ABSTRACTS OF JAPAN vol. 010, no. 236 (E-428), 15 August 1986 & JP 61 068868 A (HITACHI LTD;OTHERS: 01), 9 April 1986 see abstract</p> <p style="text-align: center;">-----</p>	1,7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/01054

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